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Title:	Sensitivity Analysis using Continuous Sensitivity Equation Method (CSE)
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Sensitivity Analysis using Continuous Sensitivity Equation Method (CSE)

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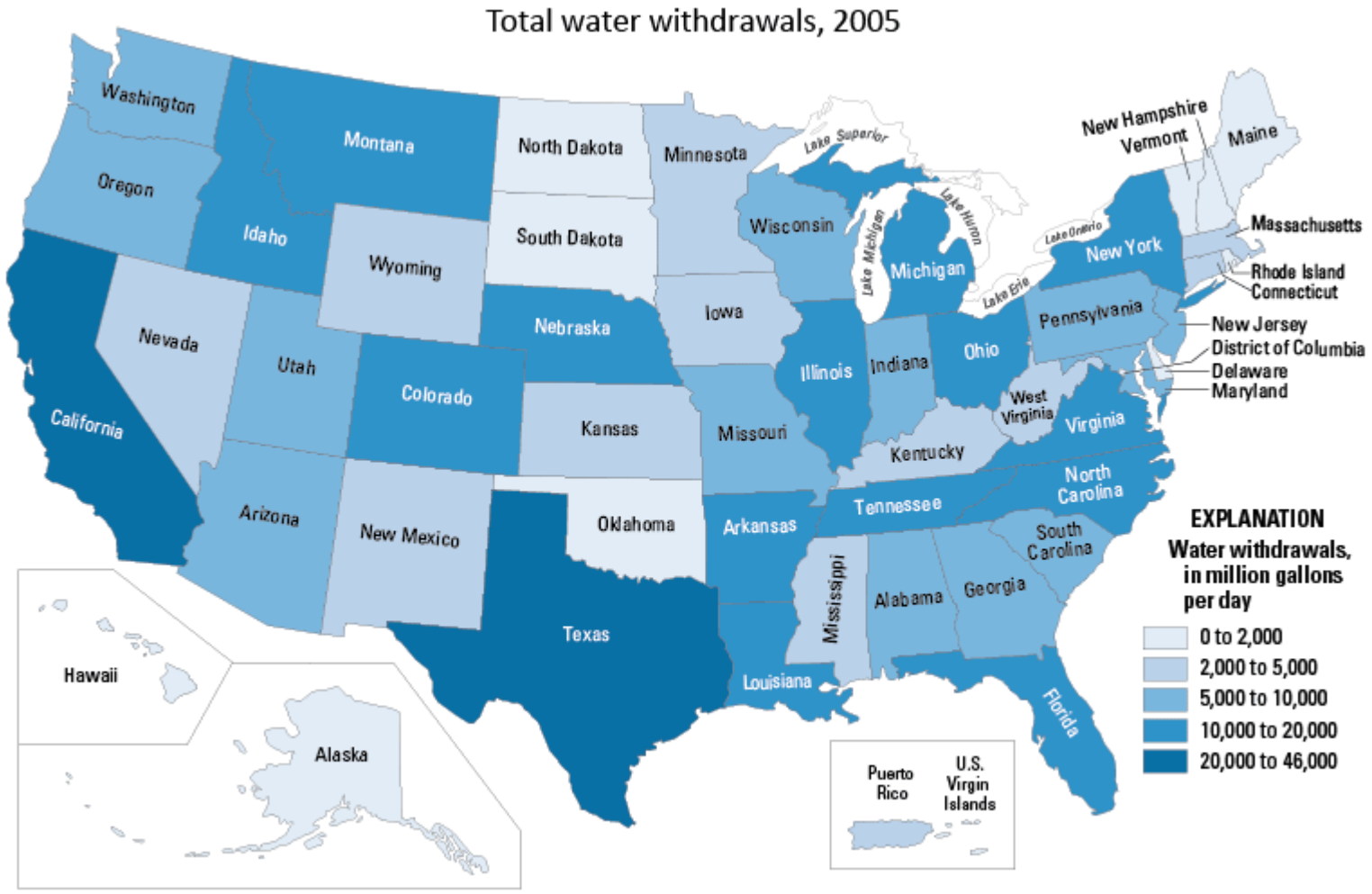
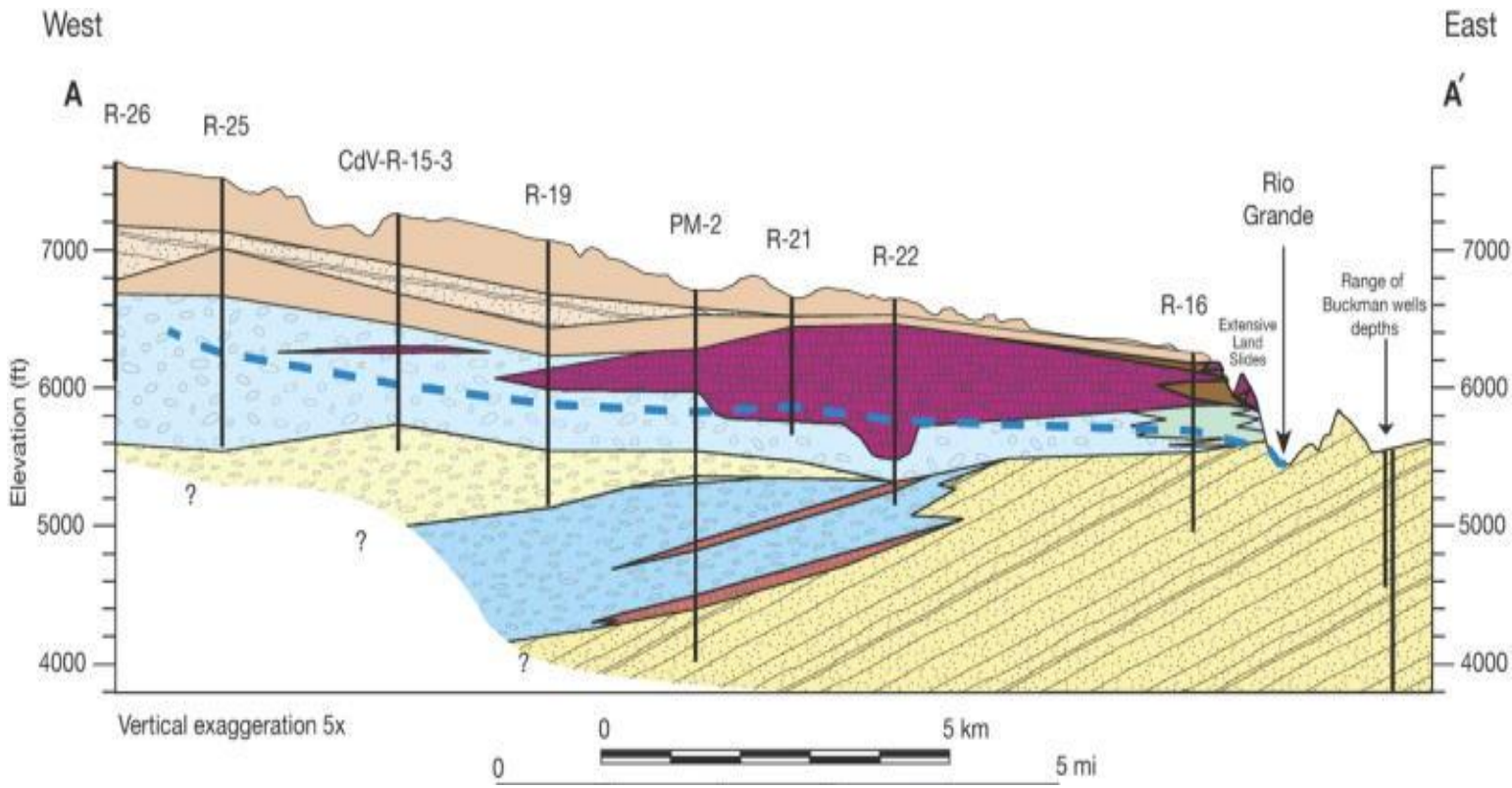
Groundwater Models are Great



Source: USGS

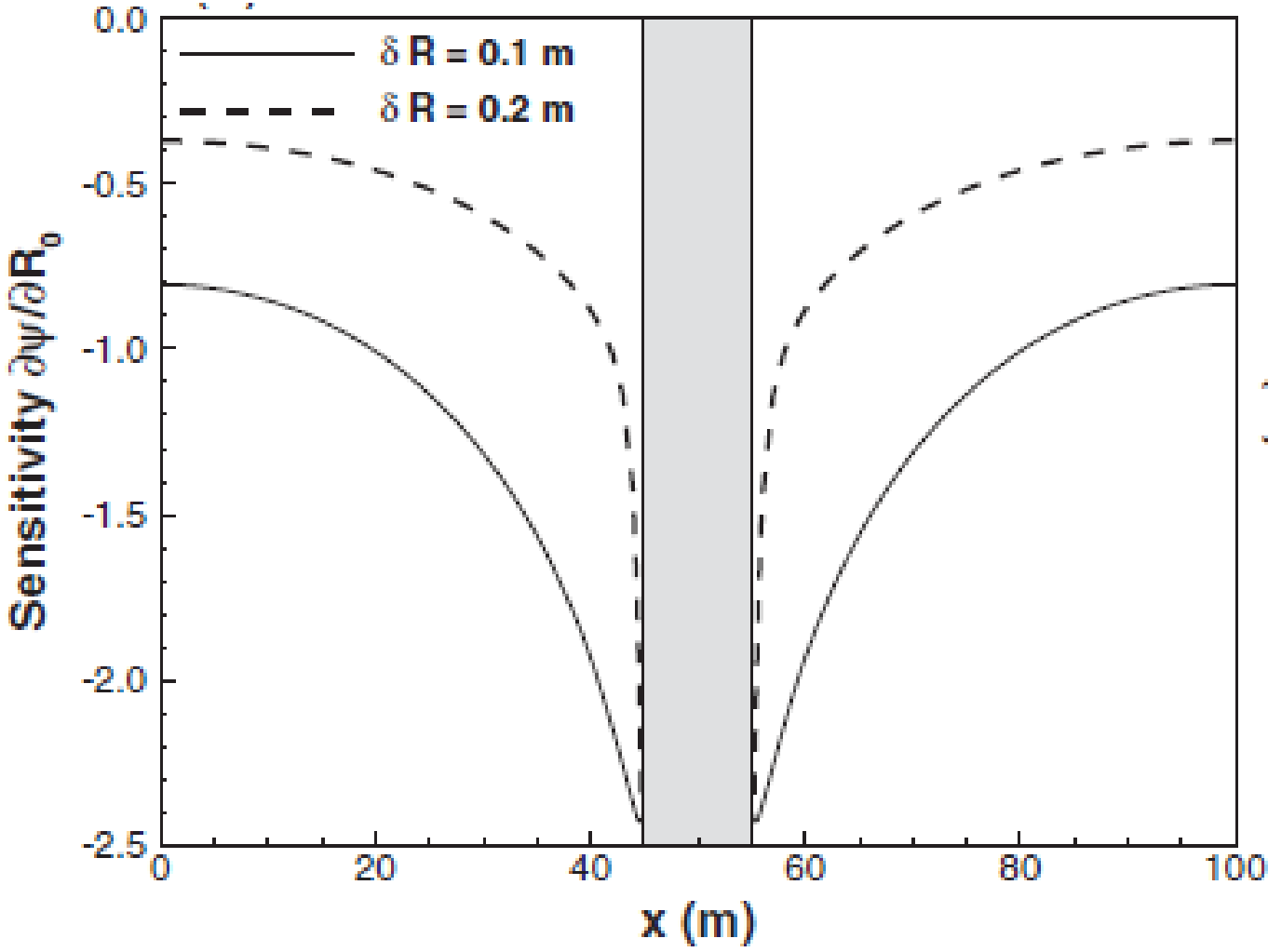
…But

- Boreholes are miles apart
- How sensitive are flow and transport are to these boundary locations?



One Solution: Finite Difference Method

- Different nodal locations
- Hard to determine best perturbation



Better Solution: CSE

- Continuous Sensitivity Equation
- Can make direct nodal comparisons
- Not dependent on perturbation
- Get more accurate sensitivities

How CSE Works

- Take derivative of flow equation
- s_h = sensitivity of head
- h = head
- a = parameter

$$s_h = \partial h / \partial a$$

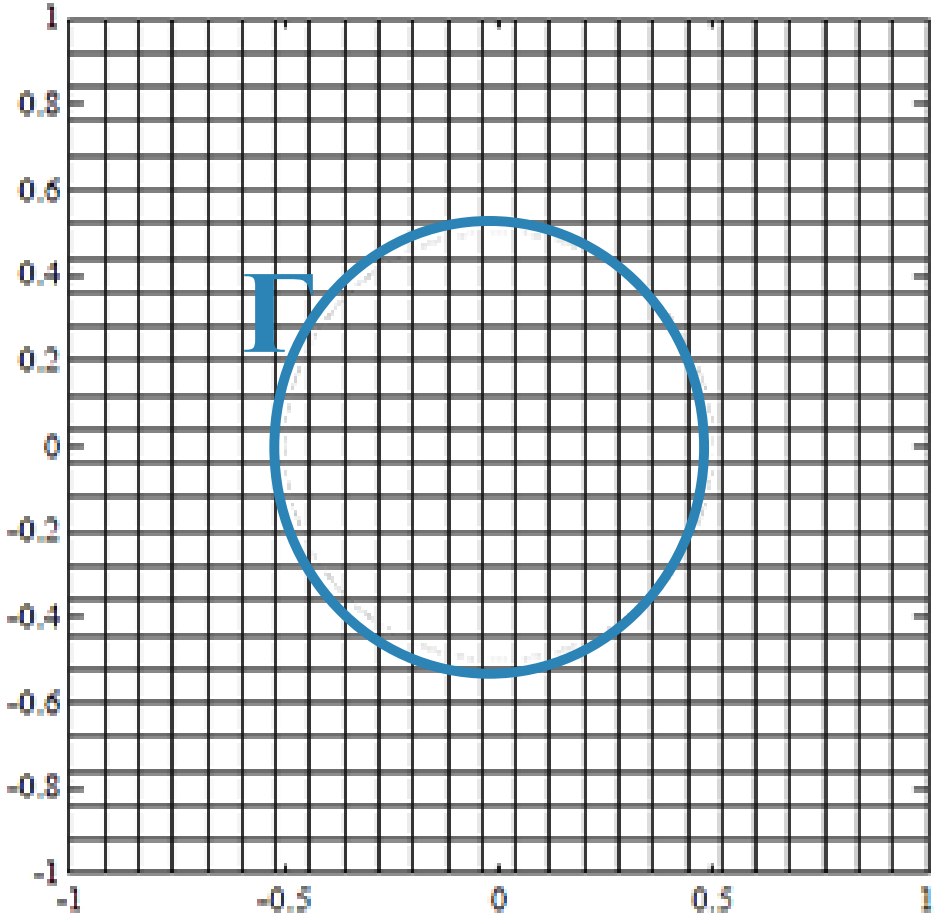
How CSE Works

- Take full derivative of boundary conditions
- u = boundary condition
- a = parameter
- $\mathbf{x}$ = boundary location

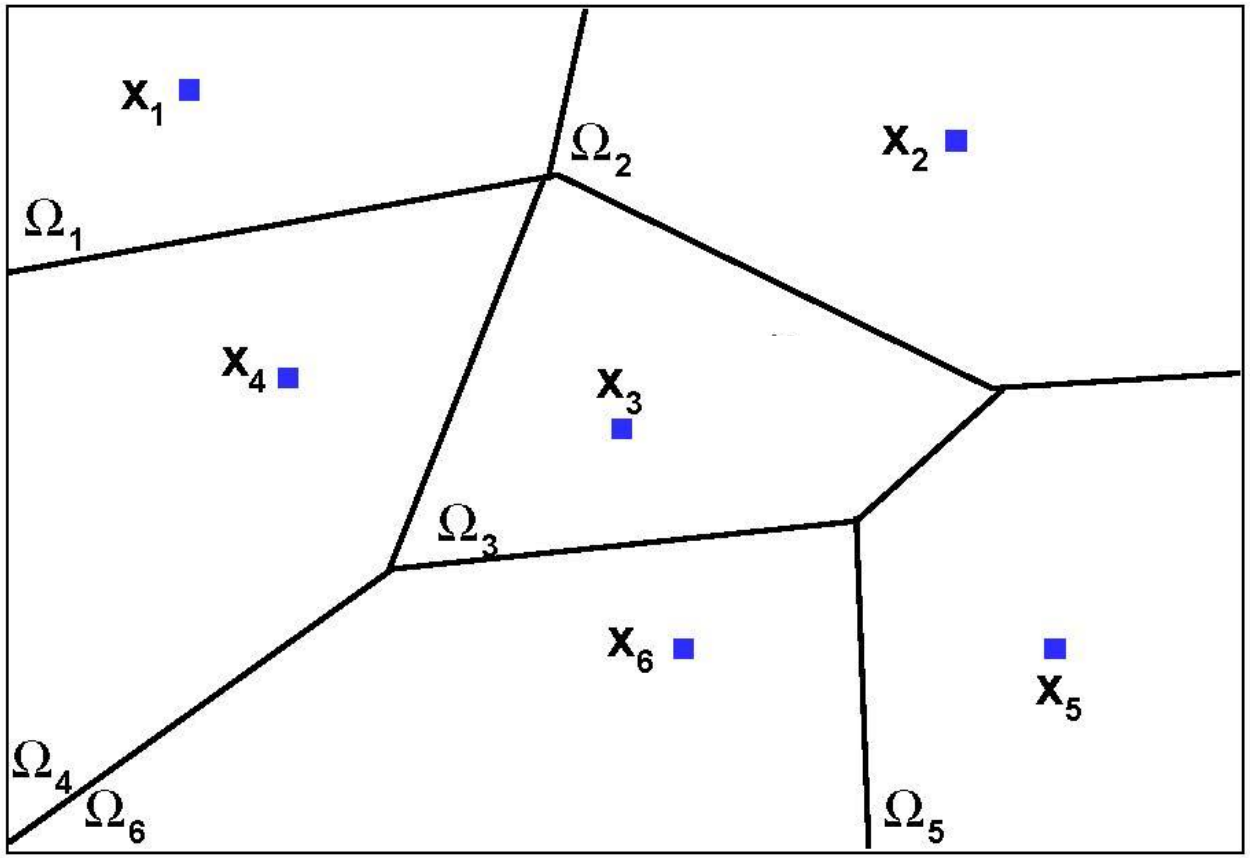
$$\frac{Du}{Da} = \frac{\partial u}{\partial a} + \nabla u \cdot \frac{\partial \mathbf{x}}{\partial a},$$

Implementation

Immersed Interface Method (Li, 1994)



Example



Example

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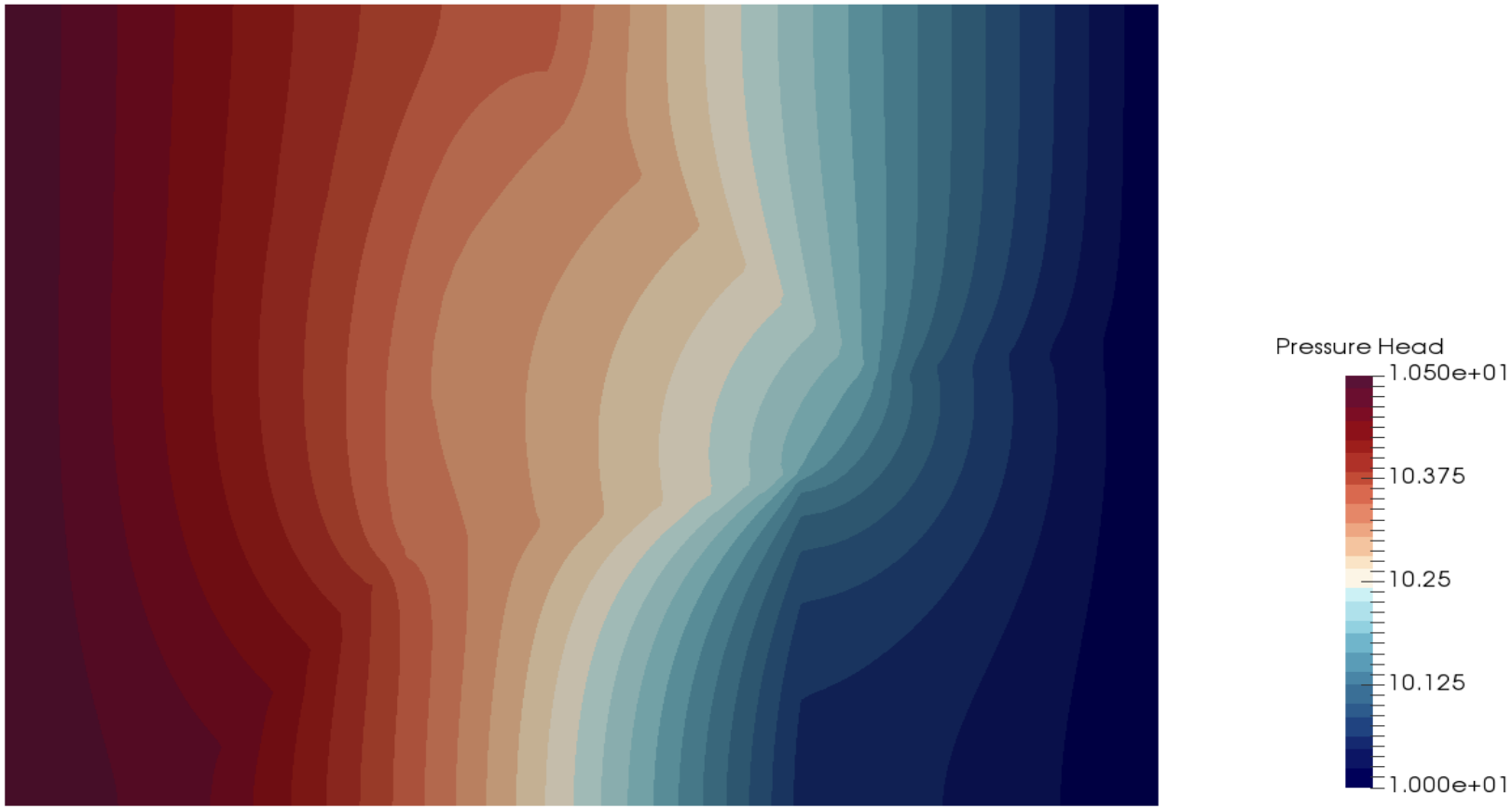
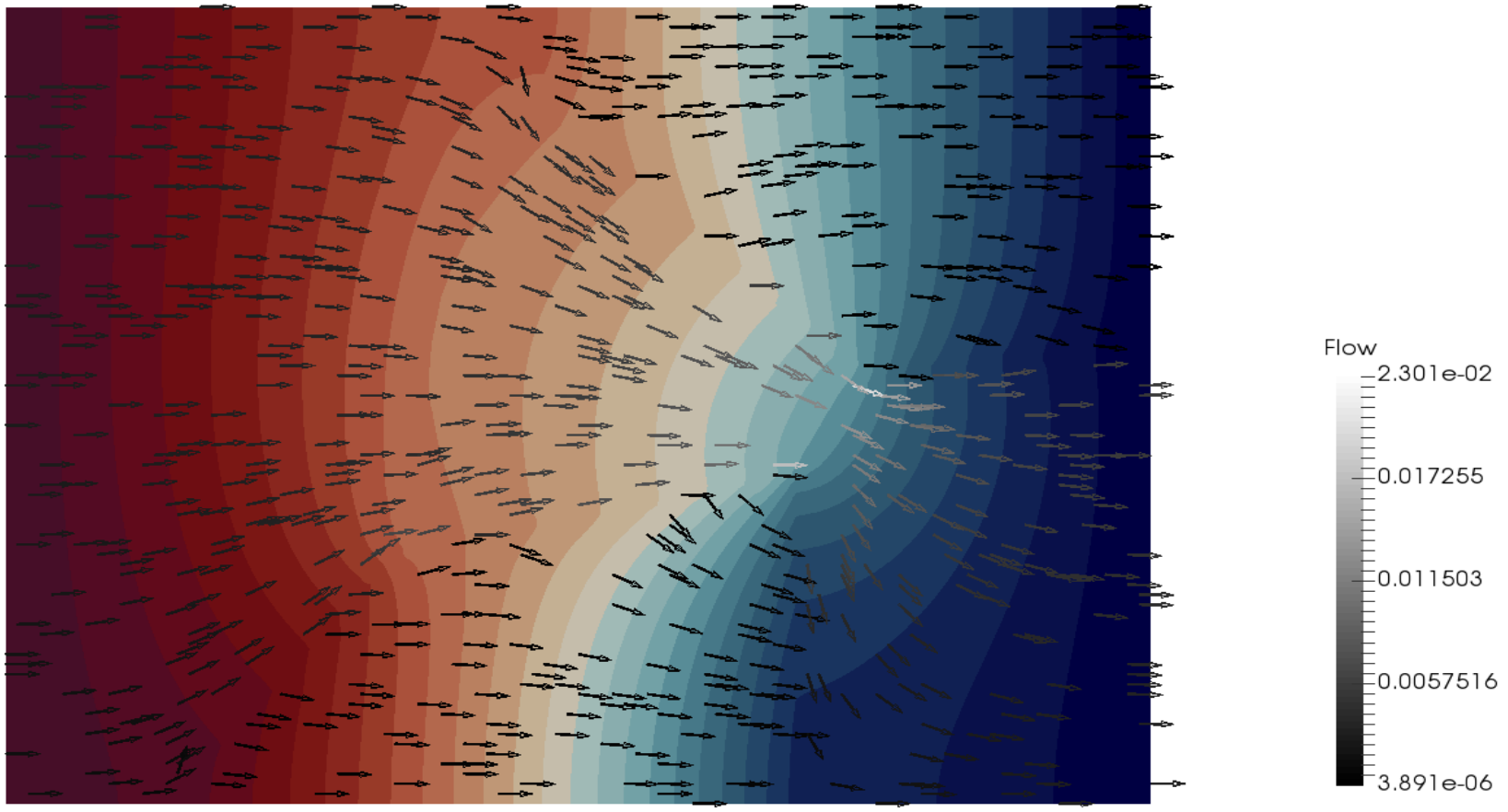


Example



Conclusions

- Using the Continuous Sensitivity Equation can give an accurate, analytical solution for sensitivity

- CSE can be implemented using Immersed Interface Method

Thank You!

- My Mentor Lu Zhiming
- DOE Minority Serving Institution Partnership Program
- All the great EES-16 people I met